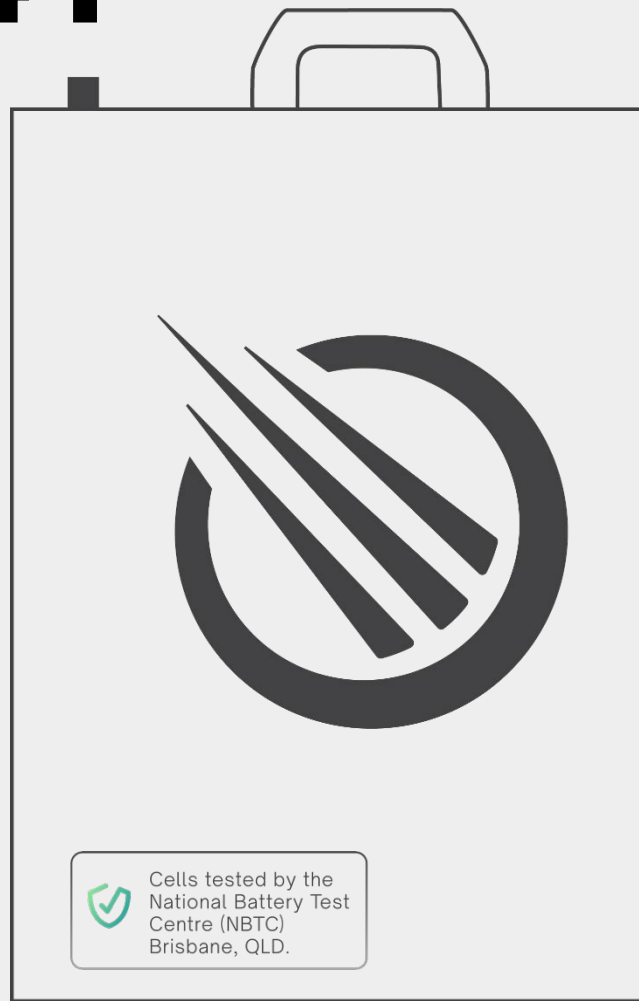


Installation and Operation Manual

Troppo-4841

Self-managed Lithium Battery (LFP)



RedEarth's own battery, Troppo, is the first Australian-made and owned battery approved and listed by the Clean Energy Council.



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Safety instructions

Installers and users are responsible for familiarising themselves with this manual.

The Troppo-4841 battery is certified to IEC62619:2017, IEC60950 and UN 38.3. It is listed on the Australian CEC (Clean Energy Council) list of approved batteries. IEC62619 is required to be able to sell this type of battery in Australia.

The Troppo battery uses high-quality cylindrical Lithium Ferro Phosphate (LFP) cells which are safe, robust, and reliable in higher ambient temperatures. The cells themselves are also certified to IEC62619 (2015) by TÜV, specifically for RedEarth, and have industry leading service life. They are fully recyclable.

Each Troppo battery self-manages its operation via an internal Battery Management System (BMS) designed by RedEarth that provides high surge capacity together with protection against operation in over and under temperature, over and under voltage, over current (charging), as well as short circuit (discharging) protection. It also extends the service life of the battery through internal balancing of the individual cell strings.

The maximum short-circuit current for each Troppo battery is 0.4kA. If multiple Troppo batteries are installed, then the maximum short circuit current of the battery bank is: $0.4kA \times \text{number of Troppo batteries connected in parallel}$. **Note** that the Troppo battery is only designed to be connected in parallel as a nominal 48Vdc string of batteries. They will not work if connected in series.

Low voltage protection feature: The Battery Management System (BMS) has a feature that shuts down the battery if the battery becomes deeply discharge and the voltage falls below 40V \pm 2 volts. This is to protect the cells from damage. See the relevant section of this instruction manual to restart the battery.

The battery includes a 2-pole non-polarised circuit breaker (K-curve) specifically manufactured for RedEarth. A 2-pole circuit breaker is required to meet Australian standards for battery installations. A single pole circuit breaker alone is not normally sufficient in Australia as batteries are usually installed with a floating negative, unlike e.g., in the USA where the negative terminal is usually grounded to earth and so only a single-pole circuit breaker is required on the positive cable.

Other safety features of the Troppo battery include the use of touch-safe high-quality industry standard Amphenol Surlok DC connectors for safe and easy connection of the DC battery cables. These have a significant safety advantage over legacy systems using exposed bolted terminals. Bolted connections present a short-circuit risk as well as the possibility of a loose connection becoming a hot-joint.

The display included in the Troppo battery increases safety by showing the voltage and current status of the battery at all times, including arrows indicating if the battery is charging or discharging. This is helpful when batteries are being connected in parallel, and larger balancing currents can flow if the battery voltages are not similar. Note that the BMS includes a safety feature that does not allow current to flow if the battery voltages are different by more than 2-3 volts. Bring the battery voltages closer together by charging or discharging one of the batteries before reconnecting.

The display also includes an odometer function that shows the total energy in kWh that has flowed out of the battery over its lifetime. The Troppo battery is warranted to deliver at least 10,000kWh over its lifetime. It can also be useful for indicating if one battery in a string is not doing as much work as other batteries.

A status indicator light is also included on the battery. This is always lit when the battery circuit breaker is on, and the battery is ready for use. If the battery has shutdown due to under-voltage protection shutdown, then it will not light up. The light also incorporates a momentary button feature that is for future developments of the battery.

Installation:

Installation should only be performed by qualified and experienced installers who can specify the correct cable sizes and DC bus arrangement, external circuit protection, polarity checking and suitability of the design for the application.

Note: RedEarth provides Troppo battery compatible, factory built and tested pre-wired battery enclosures and energy storage systems designed and engineered to meet Australian standards. These can significantly simplify installation.

Transportation:

Lithium Ferro Phosphate Batteries are classed as Dangerous Goods (DG) Class 9 UN3480 and therefore safe for transport. The batteries are shipped in approved transport protection packaging in a partially discharged state with terminal protection in place and the circuit breaker off.

Basic Safety and handling:

- Battery pack is intended to be a 2 person lift when being installed.
- Battery should not be exposed to temperatures above or below the temperature rating specified in this manual.
- Battery should not be installed where it is in direct sunlight, or where it can become wet.
- Battery should not be exposed to strong impacts, crushed, or punctured.
- Do not short the battery terminals or connect with reverse polarity!
- Battery should not be disassembled unless qualified and approved by RedEarth to do so.
- Battery should be kept away from animals and children.
- The maximum stacking height for transport is 8 batteries when in RedEarth's transport box.

Damaged battery:

A damaged battery must not be used and should be returned to RedEarth as soon as possible or disposed of via a recycling facility. Leaking electrolyte can cause skin irritation and chemical burns so contact should be avoided.

Eye Contact:	Rinse gently with running water. Seek medical attention if irritation develops.
Skin Contact:	Rinse gently with running water. Seek medical attention if irritation develops.
Ingestion:	If ingested do not induce vomiting and contact your local poisons information centre or doctor.
Inhalation:	Evacuate area and seek professional medical attention immediately, however an inhalation hazard is not expected due to product form and nature of use.

Fire:

In the unlikely event of a fire a dry agent fire extinguisher should be available and used. DO NOT use water. Evacuate the area and call emergency services. Toxic gas may be produced if the battery catches fire.

SDS:

Note: Refer to the SDS document for more details. The SDS is available from RedEarth Energy Storage Ltd and at www.redearth.energy

Overview

The Troppo-4841 Battery is RedEarth's own in-house developed and built lithium-ion battery, using safe LFP technology. It is an Australian-made product that is designed and assembled by RedEarth in its facility in Brisbane.

The Troppo battery's features make it one of the easiest and safest lithium-ion batteries to install and use, and you have the support of RedEarth's experienced Brisbane-based technical team behind you. Just call.

The Troppo battery has been specifically designed to be self-managing. This means it does not need to communicate with the inverter/charger to operate. There is no need for multiple communication wires between the batteries and inverter (and the complications that go with configuring it), making installation simple. It also allows the battery to be used in systems which do not have the capability to communicate with batteries. For example, older lead-acid based battery systems that need a replacement battery.

Troppo batteries include a display that shows the battery voltage and current. It also includes an odometer that shows how many "miles" the battery has done in its lifetime (measured in total kWh delivered by the battery). It is warranted to deliver at least 10,000kWh over its lifetime, so if it is reading 2,000kWh, then it is only 20% of the way through its life.

Battery connectors are industry standard, safe and easy to connect Amphenol connectors. A built-in two pole circuit breaker allows for time and cost savings during installation.

The batteries can be connected in parallel to suit applications from the smallest domestic application, right through to telecommunications and commercial sized projects (note: they are not suitable for series connection).

The battery can be coupled with many of the inverters available in Australia today, see www.redearth.energy/troppo. RedEarth can also assist you in selecting the requirements for your system and setting the appropriate parameters.

The Troppo operates at a nominal 48Vdc. It is sized to be installed in standard 19" racks, if required. RedEarth also provides its own range of purpose built 19" enclosures for this purpose.

Qualified installation person (installer)

The installation tasks described in this manual should be carried out by a suitably qualified and skilled installer with adequate skills, qualifications, and experience. They should:

- Have a thorough understanding of operations, design, and installation principles of on- and off-grid electrical systems
- Have a thorough understanding of the risks and dangers associated with installing and using electrical equipment
- Hold all local, state and country-based qualifications to carry out such work
- Adhere to all safety and installation requirements contained in this manual

The Troppo 4841 battery is certified to IEC62619:2017, IEC60950 and UN 38.3, and is also listed on the CEC list of approved Battery Systems, allowing it to be used in Australia. It is supplied in the appropriate DG approved shipping carton.

Physical specification



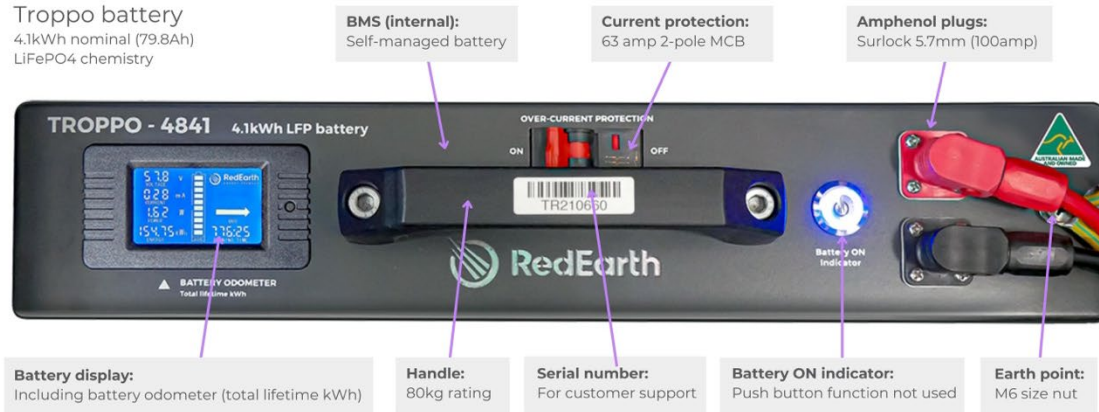
Battery weight	42.5kg
Battery dimensions	438mm wide x 725mm deep (including handle) x 88mm high (2RU)
Package weight (with battery)	44kg
Package dimensions	540mm wide x 800mm deep x 160mm high



Product description

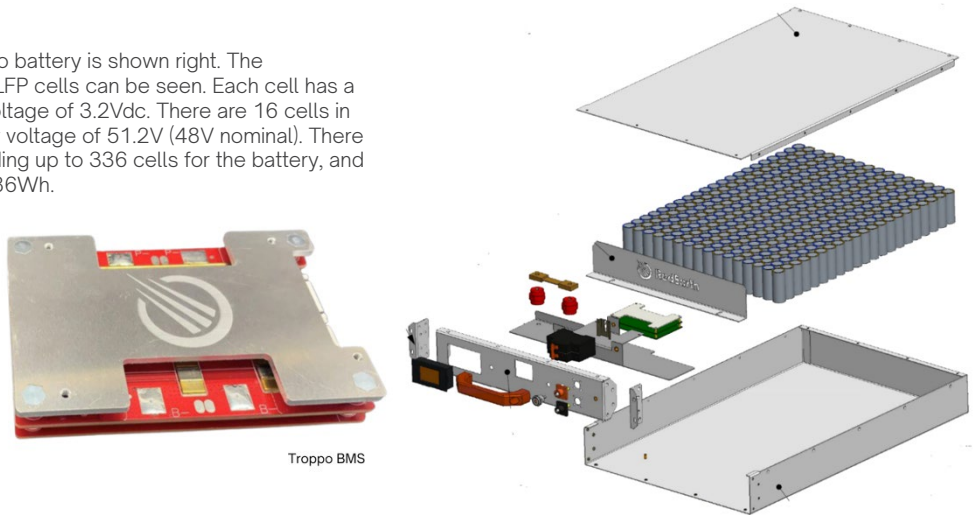
The Tropo 4841 battery is a lithium Ferro Phosphate (LFP) battery that contains a Battery Management System that manages the battery cells. It does not need to communicate with the charger or inverter; however, it is important that the charger and inverter are programmed to provide the correct voltage and current for the Tropo battery.

The image below shows the battery face cover plate including where the connection and control components are located.



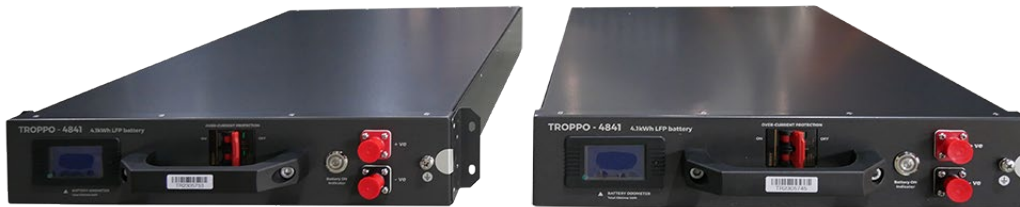
An exploded view of the Tropo battery is shown right. The arrangement of the cylindrical LFP cells can be seen. Each cell has a capacity of 3,800mAh and a voltage of 3.2Vdc. There are 16 cells in series which provides a battery voltage of 51.2V (48V nominal). There are also 21 cells in parallel adding up to 336 cells for the battery, and a total nominal capacity of 4,086Wh.

Note: Do not open the battery. There are no user serviceable components, and it will void the battery warranty.



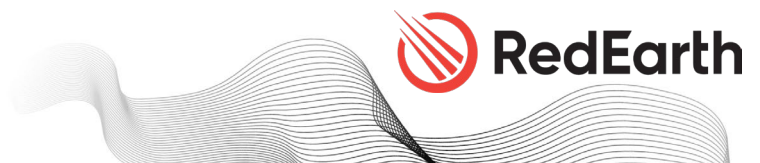
Optional battery securing mounts

If required, bolt-on wings can be provided to secure the battery to a standard 19" rack.



↑ Pictured: Bracket wing setup for a 19-inch rack (rack depth ≥800mm)

↑ Pictured: Standard for use in installations not using a 19-inch rack



Understanding the Troppo battery and its use

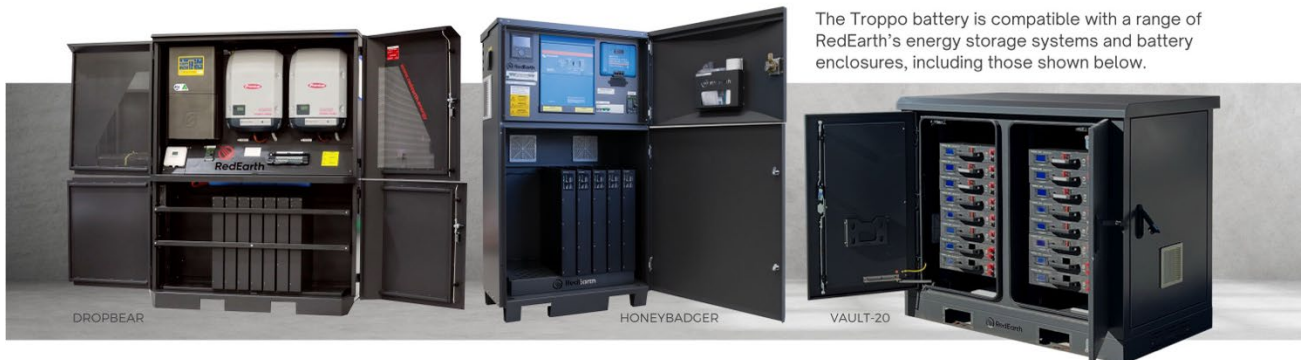
The Troppo battery is designed to be easy to install and use. It can be used in applications requiring a nominal 48Vdc battery bank. The Troppo battery is designed for a wide range of 48V DC applications including but not limited to renewable energy systems, telecommunications, and mining applications.

As it is designed with a self-managed BMS, it does not need to communicate with the inverter/charger to operate. This makes it suitable for a larger range of applications than the typical Lithium-ion battery that requires communication with the inverter/charger to continue to operate.

The following sections of this manual explains characteristics, features, and options for use of the Troppo battery.

Additional support is available through RedEarth Technical Support by calling 1800 733 637, emailing support@redearth.energy, or visiting the RedEarth manufacturing facility in Brisbane, Australia. Further information can be found at www.redearth.energy

RedEarth offers a wide range of training options for our partners including regular training courses run at our Brisbane facility, on-site for our larger customers, as well as online training options.



The Troppo battery is compatible with a range of RedEarth's energy storage systems and battery enclosures, including those shown below.

Charging and discharging the Troppo battery

The battery should always be charged and discharged within the voltage, current and temperature ranges listed in the Troppo Battery Specifications at the end of this manual.

When connecting to third party inverters and chargers the parameters set in these devices are important for safe battery operation. The table below provides a guide to some of the key parameters to set. RedEarth also provides datasheets for setting up popular inverters and MPPTs. These are available on RedEarth's website, www.redearth.energy. If in doubt, contact RedEarth.



All currents are maximum total charging and discharging currents and should be taken into consideration when multiple devices are charging the battery (e.g., MPPT and inverter/charger).

For full warranty coverage the battery must be operated within the voltage, current and temperature windows defined below and in the specifications in this manual and the data sheet.

Inverter or charger programming: Battery parameter settings	Notes
Battery type: Lithium, user-defined or sealed lead-acid	<i>If no Lithium or user-defined option is available, then set to sealed Lead-acid</i>
Charging method: CC-CV	<i>Constant Current (CC) (.max. charge current of Troppos)...then....Constant Voltage (CV) setting of 57.6V</i>
Recommended continuous Discharge Current: Maximum 40A per Troppo battery	<i>Install sufficient batteries to ensure that the batteries are not overloaded</i>
Recommended continuous Charge Current: Maximum 40A per Troppo battery	<i>Install sufficient batteries to ensure that the batteries are not overloaded (</i>
Max. Charge/Discharge Current: Maximum 63A per Troppo battery	<i>Limited by the 63A MCB and also the fixed BMS internal charging current protection of 78amps +/- 8amps</i>
Charging end current: 0.8amps (0.01C)	<i>End Constant Voltage charging once current drops below 0.8amps per Troppo battery</i>
Continuous Charge Voltage (Absorption voltage): 57.6Vdc	<i>Recommended charge voltage of Troppo</i>
Float Voltage: Disable float, otherwise set to 53.5V	<i>Float voltage charging is not required</i>
Equalisation voltage: Disable equalisation, otherwise set to 53.5Vdc	<i>Avoid equalising the Troppo battery</i>
Inverter shutdown voltage (per Warranty): 48.0V (most of battery capacity used)	<i>Inverter stops inverting. Leaves enough capacity to avoid internal shutdown while waiting for a charging source (e.g., solar)</i>
Inverter shutdown SoC: 20% if available as an option	<i>Inverter stops inverting. Leaves enough capacity to avoid internal shutdown while waiting for recharging (e.g., solar)</i>
Restart voltage of inverter: 50V	<i>Set restart voltage of inverter at 50Vdc to allow battery to recharge enough prior to applying the load to the inverter</i>
Peukert Exponent: 1.02	<i>If required</i>
Cable size: Refer to the relevant manual or cable sizing standard	<i>Amphenol 5.7mm Surlock—rated at 120A with 25mm² cable (100A with 16mm²)</i>
Important: The inverter, charger (or MPPT) connected to the Troppo needs its battery parameters set as listed above. If the inverter shut down voltage is set too low, there is a risk that the battery switches itself off internally for protection. This then requires a manual restart of the Troppo battery.	<i>Refer to separate inverter-specific information in the Troppo manual, or on the Troppo webpage: www.redearth.energy/troppo</i>

Battery installation: Location and environment

Observe the requirements detailed in the safety instructions at the start of this manual. The Troppo battery is approved for use in three types of systems.

1. In RedEarth’s pre-built and certified Battery Energy Storage Systems (BESS)

RedEarth provides complete Ready-to-Run battery systems that use the Troppo 4841 battery. These include the BlackMax, SunRise (Mini and Maxi), HoneyBadger and DropBear systems for both on and off-grid applications. Call for details, or visit www.redearth.energy



2. RedEarth’s battery-only Vault enclosures—pre-wired

This allows qualified installers to add RedEarth’s CEC approved battery system as the storage component of a 48Vdc installation.

The **Vault-11** is an indoor-rated enclosure that is pre-wired for up to 11 Troppo batteries. Multiple enclosures can be installed at a single site.

The **Vault-9 MCCB** is configured with a built in Battery Breaker (250A NOARK MCCB) and a Victron BMV-712 battery monitor. This allows monitoring of the state-of-the-charge of the whole stack of Troppo batteries. It is pre-wired for up to 9 batteries. Optional 3G remote monitoring is also available.

The **Vault-20** is an outdoor-rated enclosure for up to 20 Troppo batteries (82kWh). Optional air-conditioning is available. Contact RedEarth for details.



3. Custom enclosures and installations

The Troppo battery is designed to be installed in a 19inch rack or another electrical enclosure of your choice. If the battery is to be installed outdoors a suitable IP54 enclosure should be used.

Troppo batteries do not vent any harmful gases and do not require special ventilation or cooling.

The location of the batteries should meet the following conditions:

- The batteries are not located in a salt-air environment, e.g., by the ocean. If this is unavoidable, then appropriate air filtration should be used to prevent salt air contacting the battery.
- There are no explosive or flammable materials nearby (refer to AS5139 and the CEC Best Practise guide <https://batterysafetyguide.com.au/>)
- Charging and discharging outside of the optimal ambient temperature range should be limited to C5 and the battery cells should remain between the max and min operation temperature range as specified in this manual. (The internal BMS will stop the operation of the battery if the cell temperatures move outside their specifications)
- The temperature and humidity remain relatively constant to avoid condensation.
- The area is clean with minimal dust.
- The batteries and battery cabinets/housings are not exposed to direct sunlight.
- The Troppo battery can be installed horizontally, vertically or on its left or right side.

RedEarth can supply connectors, bus bars, DC battery cable, battery breakers and ancillary items to assist qualified installers in completing their installations. Call RedEarth Technical support on 1800 733 637.

DC battery cables

Each battery has a positive and negative Amphenol SurLok non keyed male connector for easy snap on connection. A full range of pre-made cable and mating connectors are available from RedEarth.

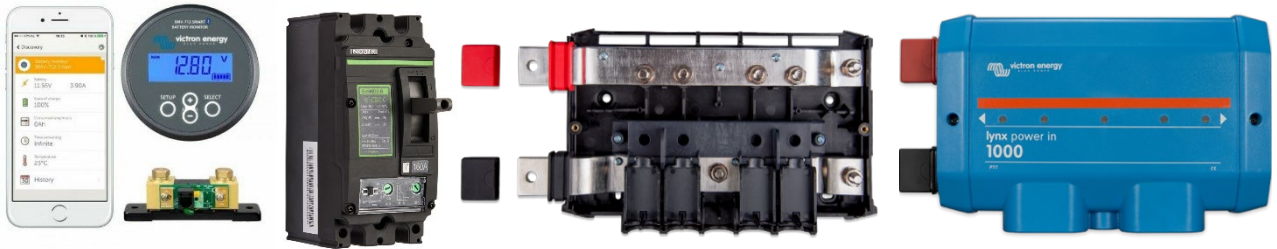
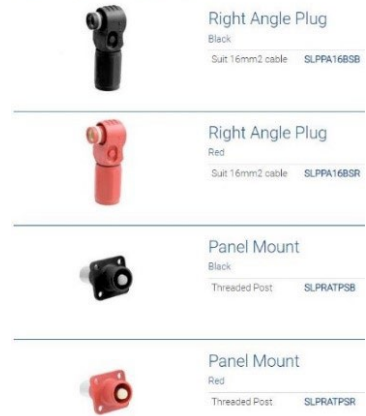
Multi-battery bus bar and DC Battery Breaker

If multiple batteries are to be connected, then RedEarth can supply a Victron busbar which is rated to 1000A. Several can be bolted together when larger numbers of batteries are required. RedEarth also uses and can supply Noark MCCBs.

Monitoring

RedEarth can supply a Victron BMV-712 monitor with alarm relay and Bluetooth capability. It is included in the Vault 9 product as standard. 3G monitoring hardware for the BMV-712 is also available (includes a pre-paid 5 year SIM card).

SurLok Plus 5.7mm (IP67)

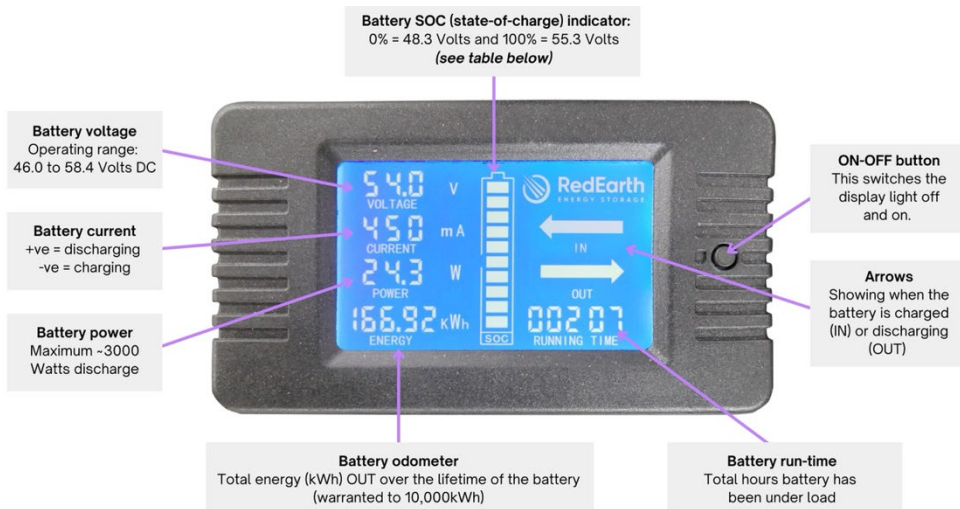


Battery connection and operation

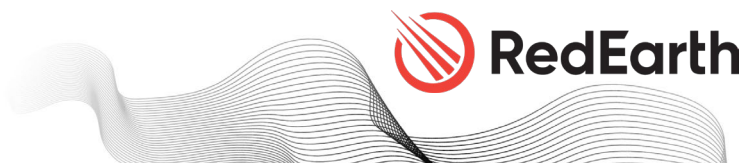
Connecting batteries together in parallel:

When connecting multiple Troppo batteries to a single inverter/charger follow the steps below,

1. **Confirm status of the battery:** On each battery switch ON the OVERCURRENT PROTECTION MCB and confirm that the display and blue indicator light illuminates. By looking at the display, confirm that the battery voltage is between 46.0 and 58.4Vdc. It is recommended that the voltages of all the batteries are within 0.5 volts of each other to avoid high current flows between the batteries once they are all connected in parallel. Note that the BMS in the batteries will not allow electrical connection if the voltage difference between the batteries is greater than 2-3 volts. Bring the battery voltages closed together by charging or discharging one of the batteries before connecting in parallel.

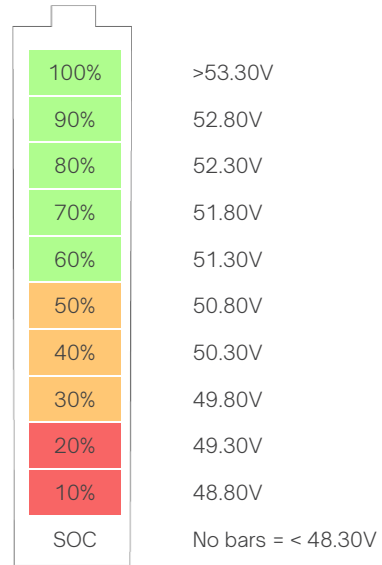


2. Switch OFF the OVERCURRENT PROTECTION MCB of all batteries.
3. Connect all the batteries in parallel, by connecting them to the main bus bar using the correct Amphenol 5.7mm Surlok cables (available from RedEarth and already included in all RedEarth systems). This busbar will be connected to the inverter/charger via a separate Main Battery Breaker (e.g., Noark MCCB). **(Double check that all the battery cables are connected with the correct polarity)**
4. Next, ensure that this Main Battery Breaker connected to the inverter/charger is OFF.



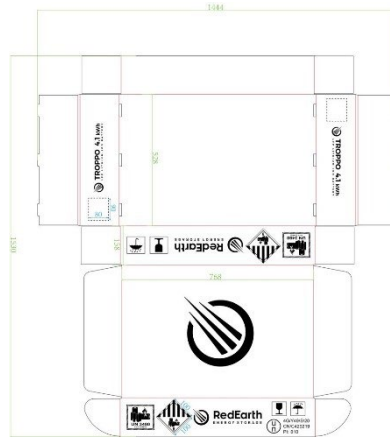
5. Switch on all the OVERCURRENT PROTECTION MCBs of the batteries and monitor the displays to ensure there are no large currents flowing. These currents will reduce quickly and will balance the batteries if their SOC was not the same. Once all balancing currents are below 5amps move to the next step.
6. Switch on the Main Battery Breaker. The inverter/charger should power-up depending on the type.
7. Adjust the parameters of the inverter/charger to match the requirements of the Troppo batteries. Refer to the settings included in this manual. **This is a critical step.** If you are unsure of the settings required contact RedEarth, as damage to batteries caused by incorrect settings of the inverter/charger will affect your warranty.
8. If you have purchased a RedEarth system with the RedEarth remote monitoring option, you can contact RedEarth now. RedEarth will log into your system and confirm that everything is operating correctly.

Troppo-4841
State-of-charge (SOC) vs. battery
voltage (with no load)



Transportation

Individual batteries are shipped in approved transport boxes that include the required shipping labels for land transportation in Australia, or in pallets of batteries up to eight batteries high.



The batteries are shipped with:

- The built-in battery switch in the off position (no voltage on the battery terminals)
- The batteries in a partial state of charge, as required for shipping in Australia. (<30% SOC)
- Plastic caps over the battery terminals for additional protection
- Optional “wings” for mounting the battery module in a 19-inch rack

Troubleshooting


The Troppo battery is a self-managed lithium battery system. This simplifies installation as no communication cables are required between the inverter/charger and Troppo batteries.

It does however require the inverter/charger settings to be correct to operate without any issues. Contact RedEarth if the following information does not solve your problem:

FLAT BATTERY RESTART

If your battery has shutdown it may be discharged below the internal protection cut-off voltage.

- 1) Turn off all loads.
- 2) Connect charging source (48V_{DC} nominal) e.g. solar, generator, AC charges.
- 3) Switch off OVERCURRENT PROTECTION switch for 5 seconds then switch back on.
- 4) Power should begin flowing into the battery. The light and display should come on. Monitor the battery voltage in the display. It should rise about 50.0V_{DC} before any loads are reconnected.
- 5) If unsuccessful, contact RedEarth on 1800 733 637 or 0487 002 451.



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Flat battery

Field experience has shown that the most common problem is the battery being discharged to the point where the internal BMS in the Troppo shuts down the battery to protect the battery cells from being discharged too deeply and therefore suffering damage. Follow the “Flat Battery Restart” procedure shown at left to restart the battery.

If this is unsuccessful you will need to apply a 48Vdc voltage to the terminals of the battery to “jump-start” it. RedEarth can supply a suitable charger, which needs to be plugged into 230Vac.



If these two steps do not work, then the Troppo battery will need to be returned to RedEarth to be reactivated.

Adding additional batteries

It is possible to add additional batteries to an existing Troppo installation at a later date.

Before adding the new Troppo battery, the original battery bank and the new battery must be bought to a similar voltage (within 0.5 volts as shown on the battery displays). This is achieved by discharging or recharging the existing battery until it is the same voltage as the new battery. The new battery can then be connected to the existing batteries.

Repairable Troppo

The Troppo battery is designed to be repairable, however this is only able to be done by RedEarth or by personnel trained and qualified by RedEarth. Attempting to repair the RedEarth Troppo will void the warranty.

Swapping the battery display

The display of the Troppo battery can be replaced without removing the battery from its installation. This requires only a small flat head screwdriver. Contact RedEarth for details. **Note** that a faulty display does not usually affect the functioning of a Troppo battery. A current meter can be used to compare the operation of the battery when compared with other batteries in the string.

Maintenance

The battery system should be checked regularly as part of your system maintenance cycle, or at least every 6 months. These checks include:

- Check the battery Display to confirm all batteries are operating as expected. Current and odometer readings are similar in each battery (within +/-5%)
- All LED indicators on the batteries are on.
- Check for any obstructions placed around the battery that may reduce ventilation.
- Check for animals, insects or creatures nesting in or around the battery system.
- Check for build-up of any foreign objects in or around the cabinet.
- Check battery connections and cables for secure fitting or cable damage. (e.g., rats eating the cables)

Options available from RedEarth

Additional batteries

One of the key advantages of the modular self-managed Troppo battery design is that additional batteries can be added to an existing Troppo installation at a later date. Additional battery modules can be ordered from RedEarth together with the required battery cables, if required. Some parameters of the inverter/charger may need to be adjusted to get the best performance from the new larger battery bank, e.g., increase the charging current setting. RedEarth's own systems that are being monitored by RedEarth can often be remotely updated. Talk to RedEarth's technical support team when you order your extra batteries.

Vault-9 MCCB, Vault-11 or Vault-20:

RedEarth can supply battery enclosures in the following sizes:

- Vault-9 MCCB: 9 x Troppo batteries with Victron BMV-712, 250A MCCB battery breaker and the option for remote monitoring
- Vault -11: 11 x Troppo batteries
- Vault-20: 20 x Troppo batteries (outdoor-rated enclosure)



Other components

Busbars, DC cable, MCCB battery breakers and battery connectors are available to qualified installers from RedEarth. RedEarth can also provide a LiFePO4 charger for an emergency should a Troppo battery have discharged to the point where it has turned off internally and will not restart. Call us to see how we can help you.

Warranty

RedEarth provides a 10-year repair/replace warranty for the battery. Refer to RedEarth's warranty document for details. It is available at www.redearth.energy/troppo. These four actions will void your warranty:

1. Incorrect battery wiring (e.g., connecting with reverse polarity or connecting batteries in series instead of in parallel)
2. Connecting the battery to incompatible equipment (e.g., 12V battery charger)
3. Incorrect inverter and/or charger settings.
4. Incorrect battery bank sizing, e.g., too few batteries for the size of the inverter.

RedEarth does not warrant for damage or defects caused by or from the following:

- Incorrect storage or transportation
- Incorrect installation and wiring
- Not installed according to this manual
- Incorrect operation of the battery
- Inappropriate environmental conditions when operating the battery
- Failure to follow safety requirements
- Tampering with the battery
- Unauthorised repairs or modifications to the battery
- External influences such as physical damage, over-charging or electrical damage
- Use outside of warranty terms and conditions

Recycling and End of Life

When a Troppo battery reaches its end of life, please return to RedEarth for recycling. Recycling is done domestically through a RedEarth partner in Victoria who reuse valuable minerals in the battery and correctly dispose of any dangerous materials. Note that the Troppo battery is designed to be repairable, unlike most other similar batteries, which is much more environmentally effective. This is also made possible as the battery is made in Brisbane.

Support from RedEarth

RedEarth has additional information on the website: www.redearth.energy, including instructional videos.

RedEarth contact details

RedEarth Energy Storage Ltd.
15 Fienta Place,
Darra (Brisbane)
QLD 4076
Australia

RedEarth office (press '2' for support):
(07) 3279 6707
1800 733 637

Technical support:
0487 002 451

Email:
support@redearth.energy

Troppo battery specifications

The table below includes all the specifications of the Troppo battery that need to be understood. It also includes additional information to help the installer to understand the specifications and parameters of the battery. More detailed information on specific settings required for common hybrid inverters and MPPTs are available separately.

The TROPPO battery incorporates a self-managed BMS that does not require communication with the inverter/charger to operate. It does however require the inverter/charger settings to be within the specifications of the battery as listed below.

Electrical characteristics	Installer information
Nominal capacity 4.1kWh / 79.8Ah	79.8Ah x 51.2Vdc (nominal battery voltage) = 4,086Wh (approx. 4.1kWh) 16S21P = 336 x 3,800mAh cells
Useable capacity 3.69kWh (90% of nominal capacity)	<u>Useable capacity</u> is the capacity available when operating the battery within the normal voltage range of the connected inverter/charger. (48.0-57.6Vdc) <u>Nominal capacity</u> is the capacity when the battery is operated from its lowest shutdown voltage up to its maximum charge voltage in a laboratory environment. (40.0-58.4Vdc)
Nominal DC voltage 51.2V	3.2V per cell (LFP type) x 16 cells in series (16S) = 51.2Vdc
Maximum discharge current 63A (Limited by circuit breaker)	63A 2-pole MCB protects battery and cabling. K-curve breaker characteristic (e.g., thermal shutdown in 3-60 mins at 75 amps)
Recommended continuous discharge current 40amps (C2)	Recommend C2 rate to get maximum life from LFP chemistry = 79.8Ah x 0.5 = 40amps dc for longest life.
Maximum charge current 63A (Limited by circuit breaker)	BMS over charging current protection is set at 78amps +/-8amps however the 63amp K-curve MCB will switch off as designed.
Recommended continuous charge current 16A	For maximum life it is recommended to charge at below 40% of C2 rate = 16amps (C2 rate = 79.8Ah x 0.5 = 40amps dc)
Maximum power on discharge (kW) approx. 3kW	Maximum 63amps x ~50 volts = approx. 3,000 Watts
Recommended operating voltage range 48.0 - 57.6 Vdc	48.0Vdc ensures the inverter stops supplying loads before the battery shuts down internally. 57.6Vdc is required for the balancing circuit inside the BMS to balance all the cell strings at the top of charge.
Charge / discharge cycles of certified 3,800mAh cells at 1C rate (to 80% residual capacity) 2,000@100% DoD / 4,000@80% DoD / 7,000@50% DoD @25°C operating temp.	4000 cycles = 10.9 years at 80% daily DoD (Depth of Discharge) when charging and discharging at 1C rate (79.8amps). This is for the cells used in the Troppo battery.
Projected MWh delivered over battery lifetime 11.77 MWh at 80% DoD (to 80% SOH)	= 4000 cycles x 4.086kWh x 80%dod x 90% av. SOH = 11.77MWh (Note: average SOH over 10 years is (100%+80%)/2=90%)
Round trip efficiency >96%	Minimal battery losses and therefore minimal internal heat generation in normal operation
Parallel connection from 4.1kWh to 100kWh+	Ask RedEarth for advice and support
Series connection Not designed for series connection	Only designed to operate in nominal 48Vdc systems- ask RedEarth for support
Expected calendar Life @25°C >10 years when used as per warranty terms	RedEarth warranty 10 years - see warranty document for details
Display and LED light characteristics	Installer information
Blue LED light Battery ON indicator	This LED indicates that the battery is on and that the BMS has not shutdown due to low battery voltage. Note that the light includes a momentary switch that is not used in the current version of the Troppo battery
Display description Shows real-time battery status as well as life-time cumulative kWh	This display shows the battery voltage as well as the real-time discharging/charging rate etc. The display also includes a life-time kWh measurement. This is a cumulative measurement of the total kWh discharged from the battery. It is measured using an internal shunt.
Display operation ON/OFF button on the display	The display light can be turned off if desired by pushing the button on the right side of the display face. Note that this display system is completely independent of the battery BMS. If it fails, it will not affect the functioning of the battery. The blue LED light will continue to function as normal.
Display SOC indicator Indicates SOC (<48.3V=0 bars >53.3V=10bars)	This indicator of battery SOC is solely based on the battery voltage. When the voltage is at or below 48.3V then none of the 10 bars are lit. For each 0.5V above 48.3V one extra bar is lit until all 10 bars are lit at 53.3Vdc. Note that charging and discharging rates will affect the voltage reading of the battery. For this reason, the SOC display is only an indicator.

Environmental characteristics	Installer information
Ambient temperature vs. cell temperature	The ambient temperature is not necessarily the cell temperature. The BMS monitors the cell temperature to decide if the cells are within their design operating range.
Operating temperature range – Discharging Discharge -20°C to 60°C (+/-5°C)	BMS shuts down discharge when the internal cell temperature sensor measures outside this temperature range. This is an abnormal situation and requires investigation. As such the battery requires a manual restart before it can be operated again.
Operating temperature range – Charging Charge: 0°C to 50°C (+/-5°C)	BMS shuts down charging when the internal cell temperature sensor measures outside this temperature range. It will automatically restart once the temperature sensor measurement moves back into the range 5°C to 50°C (+/-5°C)
Cooling Natural convection	No fans. Install in a shaded area
Physical characteristics	Installer information
Battery mounting options In a standard 19" rack or free-standing horizontally, vertically or on either side	RedEarth can provide pre-wired VAULT battery racks. We also have a range of certified fully pre-wired inverter battery systems for both on- and off-grid applications. Ensure the battery is properly installed in the given chassis to facilitate effective heat dissipation.
Battery securing mounts for 19" racks Removable "wings" supplied if required	Bolt-on wings provided to secure the battery in any standard 19" rack. Note that the rack needs to be at least an 800mm deep design.
Battery terminal connections Amphenol Surlok 100A Non Keyed	Rated to 100A if use 16mm ² battery cable and 120A if use 25mm ² batt cable. (Note: 63A MCB prevents current reaching this level)
Battery circuit breaker 2-Pole 63A 360VDC (K-Curve)	2-pole 63A 600Vdc (K-curve)
Battery dimensions 725mm D (including handle) x 438mm W x 88mm H (2RU)	Fits into a 19" rack (2RU high) and 800mm deep
Battery weight 42.5kg	Handle is rated to 80kg
IP rating IP40	Ingress Protection IP40: <u>1st number (solids)</u> - 4 = protected from wires > 1mm (this is related to the Amphenol connector) <u>2nd number (liquids)</u> - 0 = not protected
Safety parameters and certification	Installer information
Earthing	Each Troppo battery has an M6 earthing point designed to be daisy-chained together and linked to the chassis for appropriate grounding.
Short-circuit current 400 amps per battery in parallel	1) max BMS discharge protection = 400A (<0.1 seconds) 1) K-curve 63A MCB = 8-14In = 504-882 amps (<0.01 seconds)
Lithium Composition Lithium Ferro Phosphate (LiFePO ₄ or LFP)	Safest lithium chemistry (LFP)Note: LG uses NMC lithium which has higher energy density but is not as stable.
Certification - TROPPO 4841 Battery IEC:62619:2017 & UN38.3	Approved for use and transportation in Australia. Required certification for installers
Certification - LiFePO₄ 3,800mAh Cell IEC:62619:2017, UN38.3	3,800mAh Cell used in the Troppo battery is certified by TuV specifically for RedEarth
CEC listing Yes	Approved for use in Australia
Battery Management System (BMS) protection settings	Installer information
Battery type and number of cells in series LiFePO ₄ (16S)	Custom BMS designed and built to RedEarth specifications
BMS Over-Volt cut off 58.4Vdc	Maintain battery between 48.0 & 57.6 Vdc. There is very little remaining energy in the battery below 48.0Vdc
BMS Under-Volt cut off 40V	Battery will switch off internally - follow Flat Battery Restart procedure to restart the battery
Charging over-current protection 78±8A	BMS will shutdown charging above this level
Discharge over-current protection (2 levels) 250±60A(20-400mS) & 400±100A(10-100mS)	2 protection levels: 250+/-60A delay 20-400mSec 400+/-100A delay 10-100mSec
Inverter capacitors -starting capability 14,600uF	A single TROPPO battery can provide the surge current needed to start an inverter with up to 14,600uF of capacitors on the DC side.
High temperature - discharge protection 60±5°C	Battery will not discharge if both temperature sensors in the cell pack are reading above this temperature
High temperature - charge protection 50±5°C	Battery will not charge if either one of the two temperature sensors in the cell pack are reading above this temperature
Low temperature - discharge protection -20±5°C	Battery will stop discharging if one of the two temperature sensors reads below this temperature
Low temperature - charge protection 0±5°C	Battery will stop charging if temp sensors below this temperature - Required feature of all installed battery systems

Cell balancing method Passive equalisation at 57.6Vdc	Top balancing (i.e. during charging once each row of cells reaches 3.65V)
Note: In our efforts towards constant product enhancement this specification is subject to change to at anytime without notice	
Inverter or charger programming: Battery parameter settings	Installer information
Battery type Lithium, User-defined or Sealed Lead-acid	If no Lithium or user-defined option is available, then set to sealed Lead-acid
Charging method CC-CV	Constant Current (CC) (<max. charge current of TROPPOS) ...then... Constant Voltage (CV) setting of 57.6V
Recommended continuous discharge current Maximum 40A per Tropo battery	Install sufficient batteries to ensure that the batteries are not overloaded (see RedEarth recommendation)
Recommended continuous charge current Maximum 40A per Tropo battery	Install sufficient batteries to ensure that the batteries are not overloaded (see RedEarth recommendation)
Max. charge / discharge current Maximum 63A per Tropo battery	Limited by the 63A MCB and also the fixed BMS internal charging current protection of 78amps +/- 8 amps. Allow for 1hr rest between cycling at maximum current.
Continuous charge voltage 57.6Vdc	recommended charge voltage of TROPPO
Charging end current 0.8amps (0.01C)	end Constant Voltage charging once current drops below 0.8 amps per TROPPO battery (e.g., x5 batteries = 5x0.8=4amps)
Absorption voltage set to 1 hour	The battery is fully charged once the battery is kept at 57.6V for an hour and the charge current falls below 0.8A per battery.
Float voltage Disable float, otherwise set to 53.5V	Float voltage charging is not required in typical solar applications. It is required if the battery is used in UPS applications
Equalisation voltage Disable equalisation, otherwise set to 53.5Vdc	avoid equalising the TROPPO battery. Charging at too high voltage will damage the battery. The BMS will attempt to protect the battery
Inverter shutdown voltage 48.0V (most of battery capacity used)	Inverter stops inverting. Leaves enough capacity to avoid internal BMS shutdown while waiting for a charging source (e.g., solar). Note that a high discharge current pull down the battery voltage and shutdown the battery sooner. In this case the voltage will rise above 48.0V once the load is disconnected.
Inverter shut down SoC 20% if available as an option	Inverter stops inverting. This leaves enough capacity to avoid internal BMS shutdown while waiting for recharging (e.g., solar)
Restart voltage of inverter 50V	Set restart voltage of inverter at 50Vdc or above, to allow battery to recharge enough prior to applying the load from the inverter
Peukert exponent 1.02	if required
Cable size Refer to the relevant manual or cable sizing standard	Amphenol 5.7mm Surlok - rated at 120A with 25mm ² cable (100A with 16mm ²)
Note: The inverter, charger (or MPPT) connected to the Tropo needs its battery parameters set as listed above. If the inverter shut down voltage is set too low there is a risk that the battery switches itself off internally for protection. This then requires a manual restart of the Tropo battery. Refer to separate inverter-specific information in the TROPPO Installation manual, otherwise contact RedEarth.	

Overview of how a Lithium-ion battery works

Charging	Discharging
When the battery is charged, the lithium ions in the cathode material (lithium compound) migrate via a separator to between the layers of carbon material that form the anode, and a charging current flow.	When the battery is discharged, the lithium ions in the carbon material that form the anode migrate via a separator to the cathode material (lithium compound), and a discharging current flows.



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